Paragraph [0023]:

[0023] Figure 1 shows a gas turbo group suitable for executing the method according to the invention. A turbine 4 and a compressor 12 are arranged on a common shaft 15. A generator 13 is also arranged on the same shafting. The compressor 12 takes in air 21 from the environment and condenses it. The compressor 12 furthermore has an adjustable pre-guide row 121. Its position essentially determines the suction volume stream and therefore, with a given environmental temperature and given environmental pressure, the air mass flow of the gas turbo group. Condensed air 22 is supplied to a combustion chamber that will be described in further detail below. As can be seen, the condensed air is passed prior to its introduction into the combustion chamber in a counter-flow to the hot gas inside the combustion chamber along the latter’s outside walls. The combustion chamber structure is hereby convectively cooled, and the air subsequently fed to the combustion is preheated. As explained below, at least one fuel mass flow is combusted in the condensed air in the combustion chamber. Hot, compressed flue gas 24 flows out of the combustion chamber and enters the turbine 4 with a turbine inlet temperature T_3, and in which turbine the flue gas mass flow is relaxed while outputting power. The waste gas 25 flowing out of the turbine still has a high turbine outlet temperature T_4 of, for example, 500°C and higher. This waste heat potential is preferably used in a manner known per se, for example, for generating steam in a waste heat generator. The power generated during the relaxation of the flue gas is used for driving the compressor 12 and generator 13. The generator generates an effective power P_{ACT}. A corresponding measuring signal is fed to a regulator 31, and is compared there with the set power P_{SET}. Based on the regulating deviation of the power, P_{SET}-P_{ACT}, a total fuel quantity adjustment value Y_{FUEL} is calculated. Another regulator 35 records various temperature measuring values. The temperatures recorded there are regulated to set values or

limited to maximum values by controlling the position of the adjustable pre-guide row 121 via a adjustment value Y_{VIGV}. The combustion chamber comprises a preburner 1 that preferably, for reasons of operational stability, is constructed as a diffusion burner. Part of the combustion air stream is passed over the preburner. This is followed by a mixing section 14 which in this case is constructed as a vortex generator of the type of vortex generator of the burner known from EP 321 809. The mixing section hereby consists of at least two circumferential segments of a cylindrical and/or truncated-cone-shaped hollow body, which are arranged with their longitudinal axes essentially parallel to the flow direction of the combustion chamber, whereby the longitudinal axes of the individual circumferential segments are offset relative to each other transversely to the flow direction, forming tangentially-radially oriented inflow openings. A burner of the preburner stage is in fluid connection with an upstream frontal side of the mixing device, the catalytic burner stage is in fluid connection with a downstream frontal side, and the inflow openings are in fluid connection with an inflow area of the combustion chamber in such a way that during operation of the gas turbo group, a first gas mass flow coming from the preburner stage essentially flows axially through the mixing device, and a combustion air mass flow with a tangential stream component flows into the mixing device. In this way, the first air stream 26 passed over the preburner 1 is mixed with the vortexed additional combustion air. A catalytic burner stage 2 follows downstream from the mixing segment. The catalytic stage is followed by a non-catalytic, second burner stage constructed as a self-igniting combustion chamber of the type known from EP 669 500. Fluid flowing from the catalytic stage flows at a high speed into a flow channel in which vortex generators 11, especially of the type known from CH 688868, and a fuel lance 5 are arranged. The channel merges with an abrupt increase in cross-section into a combustion chamber 6, from which the fluid 24 finally flows to the turbine 4. To ensure function of the catalytic combustion chamber, the temperature T_1 at its entrance must

reach a certain minimum value, for example, of 450°C. During operation of a modern gas turbine, such a temperature is often present at the compressor outlet in load operation in any case, if the compressor works without cooling. The flow around the combustion chamber also works to heat the combustion air before it flows into the combustion chamber. However, a reliable operation requires that the minimum temperature is maintained under all circumstances upstream from the catalyzer. A partial stream $\dot{m}_P$ of the total fuel mass flow $\dot{m}_{FUEL}$ is therefore metered into the preburner 1 via a regulating element 16. The regulating element 16 is adjusted in relation to a control value Y_P. The temperature T_1 at the inlet into the catalytic stage is measured and fed to a regulator 32. The regulator 32 compares the actual temperature value T_1 with the minimum value T_{MIN} and calculates the adjustment value Y_P from it. This ensures that a minimum required inlet temperature always is present at the inlet of the catalytic combustion chamber. The regulation of the fuel mass flow to the preburner is preferably accomplished so that even with an inlet temperature of the combustion air that per se already exceeds the required minimum value, a minimum fuel quantity is always added in such a way that the preburner 1 is operated during the entire operation of the gas turbo group, even if this is not necessarily required. Such an operation indeed increases the nitrogen oxide emissions of the gas turbo group. However, this disadvantage is compensated by operational advantages. If the gas turbo group is operated, for example, at full load, the operation of the preburner 1 is typically not necessary. During a rapid load shedding or even load rejection, the temperature of the inflowing combustion air 23 very quickly drops below the minimum value, and the operation of the preburner 1 becomes absolutely necessary again. It is hereby advantageous if only its thermal power must be increased rather than having to reignite the flame of the preburner in an operating state that is transient in any case. The hot gas 26 generated by the preburner 1 is mixed in the mixing section 14 with the other combustion air. Another part $\dot{m}_C$ of the fuel mass flow is mixed with the

combustion air heated in this manner upstream from the catalytic combustion chamber 2. On the one hand, this mixing must take place in such a way that the most homogeneous fuel-air mixture possible is present on entering the catalyzer, and on the other hand in such a way that no ignition and flame stabilization of the fuel in the hot gas occurs. Naturally, the quantity of fuel converted in the catalyzer is not unlimited, since its maximum permissible temperature is limited. A regulating element 17 controlled with the adjustment value Y_C from the regulator 33 is used to measure the fuel quantity $\dot{m}_C$ into the catalyzer. The regulator 33 receives as an input value a temperature T_2, obtained in a suitable manner, at the outlet of the catalyzer. The fuel quantity $\dot{m}_C$ of the catalyzer hereby can be regulated so that the temperature T_2 reliably does not exceed a permissible maximum value T_{MAX} of, for example, 1000°C, which is tolerated by the catalyzer in permanent operation. This temperature necessarily must be higher than the minimum temperature required for the operation of the self-igniting combustion chamber 6. This operation is low in noxious substances, since a maximum possible fuel quantity is catalytically converted. A set total fuel quantity required by the adjustment value Y_{FUEL}, which exceeds the mass flow convertible overall by the preburner and catalyzer, is recorded by the regulator 34, which calculates the Y_{SEV} from it. This again affects the regulating element 18 and therefore controls the fuel mass flow $\dot{m}_{SEV}$ that is supplied to the self-igniting combustion chamber 6 via the fuel lance 5. It is critical in this example to keep the regulating element 18 completely closed as long as the minimum temperature required for operation of a self-igniting combustion chamber has not yet been achieved. With the catalyzers used today, the two temperatures in practice are however relatively close so that a safe operation of both the catalytic burner stage 2 and the self-igniting combustion chamber 6 is only possible within a relatively small temperature range for T_2. It is therefore advantageous to establish a set value for T_2 that is on the one hand one safety margin higher than the minimum inlet temperature of the self-igniting combustion chamber 6,

and on the other hand is one safety margin lower than the permanently permissible temperature of the catalytic stage 2. Based on the aforementioned temperatures, a temperature range of, for example, 950°C to 980°C would therefore be advantageous here; depending on the catalyst material used and the fuel, other temperature ranges may be advantageous also. Given the interaction of regulators 31, 33, and 34, the operation therefore takes place in such a way that at a temperature T_2 below a threshold value, initially only the catalytic burner stage is supplied with fuel. Once the temperature threshold value is reached, regulator 33 regulates via adjustment value Y_C the fuel mass flow $\dot{m}_C$ fed to the catalytic stage in such a way that the temperature T_2 remains at a set value, and an excess part of the total fuel mass flow is recorded by the regulator 34 which controls, via the adjustment value Y_{SEV}, the regulating element 18 and feeds the fuel that can be converted neither in the preburner nor in the catalytic stage to the non-catalytic burner stage. The outlet temperature from the catalytic burner stage still can be analyzed in the pre-guide row regulator 35 also and can be used for regulating interventions for the position of the adjustable pre-guide row 121. In the process, two principally different operating modes of the pre-guide row regulation can be differentiated, i.e., an operating mode that is optimized with respect to degree of efficiency and an operating mode that is optimized according to the invention with respect to noxious substances. The operating mode optimized with respect to degree of efficiency is well known per se from the state of the art and works as follows: the pre-guide row regulator 35 records the temperatures T_3 before and T_4 after the turbine in a suitable manner. The adjustable pre-guide row is kept closed in the lower partial load range. In this manner, the temperature T_4 after the turbine very quickly rises along with increasing power of the gas turbine, so that even with a relatively low power a temperature is reached that makes it possible to generate high quality live steam with a specific pressure and a specific superheating in a following waste heat steam generator, which live steam, for example, permits operation of a

steam turbine. When a set value of the turbine outlet temperature T_4 is reached, the pre-guide row is opened, and the temperature is maintained constant. At the same time, the turbine inlet temperature T_3 is monitored. When this temperature reaches a permissible maximum value, the turbine inlet temperature T_3 replaces the turbine outlet temperature T_4 as a guide value of regulation and is maintained constant at maximum turbine inlet temperature and completely opened pre-guide row until the full load is reached. In order to further increase power without increasing the process temperatures, methods for cooling the suction air and/or for cooling the air in the compressor (36, in Fig. 1) which are known per se can be used in parallel, alternatively, or preferably in a cascading manner. When injecting fluid droplets upstream from the compressor (37, in Fig. 1), as is known from FR 1 563 749, the effects supplement each other, since on the one hand water evaporating upstream from the compressor causes a cooling of the suction air and thus an increase of the combustion air mass flow, and since on the other hand the evaporation of droplets in the compressor reduces the power consumption of the compressor. This operation ensures optimum efficiency, especially during combination operation, since it ensures advantageous live steam data of a steam turbine fed from a following waste heat steam generator over a broad operating range of the gas turbo group. In emissions-optimized operation according to the invention, the catalyzer outlet temperature T_2 is used as a guide value for the pre-guide row adjustment in the partial load range: as soon as this value reaches the set value, the pre-guide row is opened. The resulting increase in the combustion air mass flow permits an increase in the fuel mass flow $\dot{m}_C$ of the catalytic stage without exceeding a permissible maximum outlet temperature T_{MAX}. This enables a low-emissions conversion of a maximum fuel mass flow in the catalytic stage. The temperature T_3 before the turbine 4 hereby continually remains relatively low at the value T_2, since no more firing occurs downstream from the catalytic stage. In order to further increase power without increasing the process temperatures, methods

for cooling the suction air and/or for cooling the air in the compressor which are known per se can be used in parallel, alternatively, or preferably in a cascading manner. When injecting fluid droplets upstream from the compressor, as is known from FR 1 563 749, the effects supplement each other, since on the one hand water evaporating upstream from the compressor causes a cooling of the suction air and thus an increase of the combustion air mass flow, and since on the other hand the evaporation of droplets in the compressor reduces the power consumption of the compressor. Only when the pre-guide row 121 is completely opened and/or if other measures for increasing the combustion air mass flow, such as, for example, the cooling of the suction air and, in particular, the injection of fluid droplets upstream from the compressor and/or into the compressor, have been fully utilized, the fuel mass flow of the catalytic stage can no longer be further increased, and the following, non-catalytic burner stage is taken into operation for an additional power increase until the turbine inlet temperature T_3 reaches its permissible maximum value and the maximum power of the gas turbo group is therefore reached. This operation is characterized in that essentially the entire fuel mass flow is converted almost emissions-free in the catalytic burner stage over a broad operating range, and an operation with less noxious substances than in the efficiency-optimized operating mode is ensured even up to the full load operating point. In contrast, the temperature T_4 after the turbine remains low over a broad operating range, i.e., too low to generate live steam in a waste heat steam generator following the turbine for efficient operation of a steam turbine in combination operation. As already explained above, a gas turbo group operated according to the concept according to the invention is therefore suitable for optimizing waste heat use, in particular in combination with the power plant system described in WO 03/076781. Because the catalyzer outlet temperature need not be used for power regulation in the upper power range in any operating mode and, independently from the machine operating point, there exists the advantageous possibility to always operate the

catalyzer somewhat below the permissible maximum temperature, there is no risk of flashback, and the catalyzer can be constructed somewhat longer than would be actually necessary. This results in better controlled combustion and better operating behavior beyond the design point. There is also greater freedom in selecting the catalyst material, which, among other things, may result in a substantial cost advantage, and the band width of convertible fuels becomes broader without having to tolerate an increased flashback risk.